Homework

2. You put 500 ml (500g) of water in a 1200W kettle connected to a 120V wall socket. Determine the

a) current through the heating element

I = P/V = 1200/120=10 A - max out the fuse at 10A for home use - fuse - if the current is over a certain amount it flips or breaks. (use metals with different thermal expansion rates)

a) resistance of the heating element

R=V/I = 120/10=12 Ω or R = V^2/P 120^2/1200= 12 Ω

a) time to bring the water to the boiling point from 20ºC (c=4180J/kgK)

Q=mcΔT = Pt

t= (0.500x4180x(100-20))/1200=139.3333
139.33s = 139.3333/60=2.3222
2 minutes 19s

a) efficiency of the kettle if it takes 20minutes

(0.500x4180x(100-20))/(20x60)=139.3333 Pout

efficiency = Pout/Pin x 100
= 139.333/1200=0.1161 = 12% efficient

AC/DC - AC is alternating current

DC is direct current

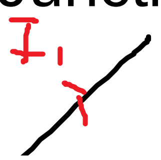
AC is sinusoidal - North America - frequency 60Hz
120V represents the root - mean square voltage - rms - sum the square of the values, then take the square root
170V is the peak voltage

$V_p = \sqrt{2}\, V_{rms}$
average power = $V_{rms}\ I_{rms} = V_p/\sqrt{2}\ \times I_p/\sqrt{2}$
$P_{avg} = P_{peak}/2$

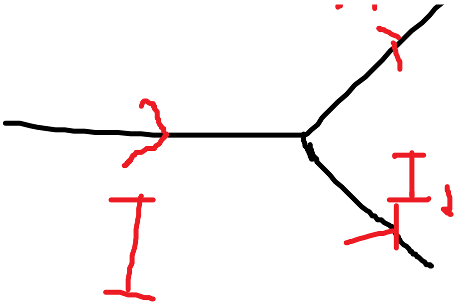
average power is used for calculate the amount of energy over time being transferred to the circuit element

Kirchhoff's Laws
You can derive KL from law of conservation of charge and the law of conservation of energy

Kirchhoff's Junction Law



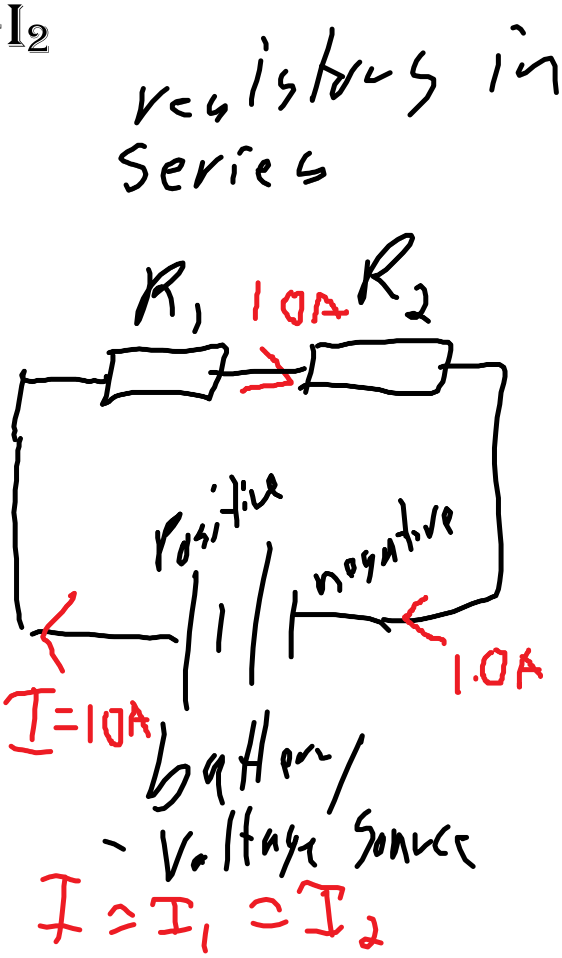
if the total charge is

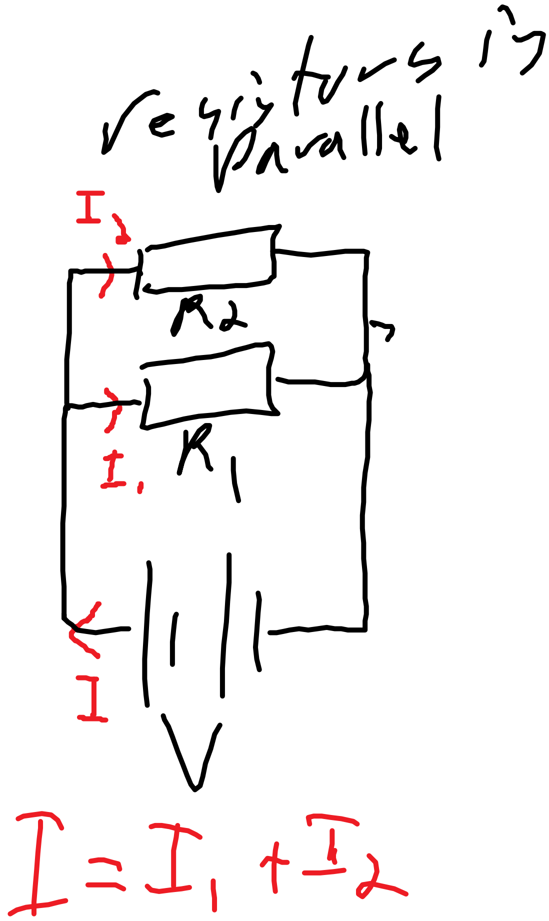


if the total charge is conserved, then the current into the junction must equal the current out

$I = I_1 + I_2$

KJL





The current out of the battery=the current into the battery, current into each resistor = current out of that resistor

assumptions: wires have zero resistance, like ammeters and galvanometers
Voltmeters have infinite resistance
if batteries or cells have internal resistance, you

will have to work it out

conservation of energy Pin = Pout
$VI = V_1I_1 + V_2I_2$
VI is the power in from the battery with voltage V and current out/in of the battery I
V_1I_1 is the voltage across resistor 1 and the current through resistor 1
but the currents are all equal in the series circuit

$VI = V_1I + V_2I$ I cancels so
$V= V_1 + V_2$

voltages in series around a loop cancel out
Vin from the battery = Vout 2 resistors for series circuit

Parallel?
$VI = V_1I_1 + V_2I_2$
$I = I_1 +I_2$
those equations are only both valid if
$V = V_1 = V_2$ voltages in parallel are equal

mixed series and parallel:

$V - V_1 - V_2 = 0$

$\rightarrow V = V_1 + V_2$

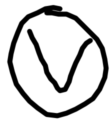
$\rightarrow V = V_1 + V_2$

loop 2

$V - V_1 - V_3 = 0$

$V = V_1 + V_3$

eg. given a 3.0 V battery connected to R_1 = 50.0Ω and R_2 = 100.0Ω R_3 = 200.0Ω



a) draw an ammeter and voltmeter on the circuit to measure voltage and current through the 100.0Ω resistor.

b) what is the equivalent resistance, R_T, of the two parallel resistors? the 3 resistors together?

c) What is the current out of the battery?

d) what is the voltage drop across R_1?

e) therefore, what is the voltage drop and current through R_2?

f) which resistor dissipates the most energy?

Big Idea

Kirchhoff's Loop Law, KLL

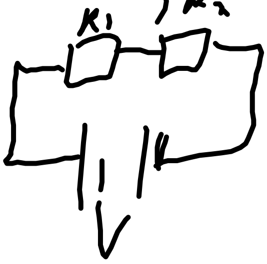
Voltages around any loop add to zero.

In the above circuit - $V = V_1 + V_2$ or

$V = V_1 + V_3$

define $R_T = \frac{V}{I}$

Series

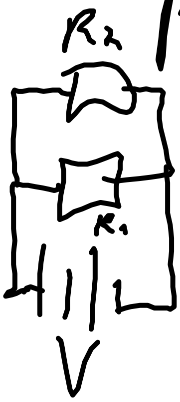


$V = V_1 + V_2$

$\cancel{I} R_T = \cancel{I_1} R_1 + \cancel{I_2} R_2$

$$R_T = R_1 + R_2$$ Series

Parallel



$I = I_1 + I_2$

$V = V_1 = V_2$

$$\frac{V}{R_T} = \frac{V_1}{R_1} + \frac{V_2}{R_2}$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$ Parallel